DISCRETE SEMICONDUCTORS

# DATA SHEET

# BFM520
## Dual NPN wideband transistor

Product specification
Supersedes data of 1995 Sep 04

1996 Oct 08

### FEATURES

- Small size
- Temperature and $h_{FE}$ matched
- Low noise and high gain
- High gain at low current and low capacitance at low voltage
- Gold metallization ensures excellent reliability.

### APPLICATIONS

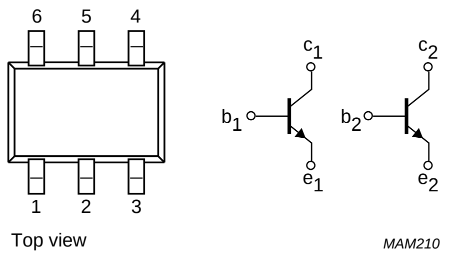
- Oscillator and buffer amplifiers
- Balanced amplifiers
- LNA/mixers.

### DESCRIPTION

Dual transistor with two silicon NPN RF dies in a surface mount 6-pin SOT363 (S-mini) package. The transistor is primarily intended for wideband applications in the GHz-range in the RF front end of analog and digital cellular phones, cordless phones, radar detectors, pagers and satellite TV-tuners.

### PINNING - SOT363A

| PIN | SYMBOL | DESCRIPTION |
|---|---|---|
| 1 | $b_1$ | base 1 |
| 2 | $e_1$ | emitter 1 |
| 3 | $c_2$ | collector 2 |
| 4 | $b_2$ | base 2 |
| 5 | $e_2$ | emitter 2 |
| 6 | $c_1$ | collector 1 |




**Marking code**: N2.

Fig.1 Simplified outline and symbol.

### QUICK REFERENCE DATA

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| **Any single transistor** | | | | | | |
| $C_{re}$ | feedback capacitance | $I_e$ = 0; $V_{CB}$ = 3 V; f = 1 MHz | – | 0.4 | – | pF |
| $f_T$ | transition frequency | $I_C$ = 20 mA; $V_{CE}$ = 3 V; f = 900 MHz | – | 9 | – | GHz |
| $\|s_{21}\|^2$ | insertion power gain | $I_C$ = 20 mA; $V_{CE}$ = 3 V; f = 900 MHz; $T_{amb}$ = 25 °C | 13 | 14.5 | – | dB |
| $G_{UM}$ | maximum unilateral power gain | $I_C$ = 20 mA; $V_{CE}$ = 3 V; f = 900 MHz; $T_{amb}$ = 25 °C | – | 15 | – | dB |
| F | noise figure | $I_C$ = 5 mA; $V_{CE}$ = 3 V; f = 900 MHz; $\Gamma_S = \Gamma_{opt}$ | – | 1.2 | 1.6 | dB |
| $R_{th\ j\text{-}s}$ | thermal resistance from junction to soldering point | single loaded | – | – | 230 | K/W |
| | | double loaded | – | – | 115 | K/W |

## LIMITING VALUES

In accordance with the Absolute Maximum System (IEC 134).

| SYMBOL | PARAMETER | CONDITIONS | MIN. | MAX. | UNIT |
|---|---|---|---|---|---|
| **Any single transistor** | | | | | |
| $V_{CBO}$ | collector-base voltage | open emitter | – | 20 | V |
| $V_{CEO}$ | collector-emitter voltage | open base | – | 8 | V |
| $V_{EBO}$ | emitter-base voltage | open collector | – | 2.5 | V |
| $I_C$ | DC collector current | | – | 70 | mA |
| $P_{tot}$ | total power dissipation | up to $T_s$ = 118 °C; note 1 | – | 1 | W |
| $T_{stg}$ | storage temperature | | –65 | +175 | °C |
| $T_j$ | junction temperature | | – | 175 | °C |

## THERMAL CHARACTERISTICS

| SYMBOL | PARAMETER | CONDITIONS | VALUE | UNIT |
|---|---|---|---|---|
| $R_{th\ j\text{-}s}$ | thermal resistance from junction to soldering point; note 1 | single loaded | 230 | K/W |
| | | double loaded | 115 | K/W |

**Note to the Limiting values and Thermal characteristics**

1. $T_s$ is the temperature at the soldering point of the collector pin.

## CHARACTERISTICS

$T_j$ = 25 °C unless otherwise specified.

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| **DC characteristics of any single transistor** | | | | | | |
| $V_{(BR)CBO}$ | collector-base breakdown voltage | $I_C$ = 2.5 μA; $I_E$ = 0 | 20 | – | – | V |
| $V_{(BR)CEO}$ | collector-emitter breakdown voltage | $I_C$ = 10 μA; $I_B$ = 0 | 8 | – | – | V |
| $V_{(BR)EBO}$ | emitter-base breakdown voltage | $I_E$ = 2.5 μA; $I_C$ = 0 | 2.5 | – | – | V |
| $I_{CBO}$ | collector-base leakage current | $V_{CB}$ = 6 V; $I_E$ = 0 | – | – | 50 | nA |
| $h_{FE}$ | DC current gain | $I_C$ = 20 mA; $V_{CE}$ = 6 V | 60 | 120 | 250 | |
| **DC characteristics of the dual transistor** | | | | | | |
| $\Delta h_{FE}$ | ratio of highest and lowest DC current gain | $I_{C1} = I_{C2}$ = 20 mA; $V_{CE1} = V_{CE2}$ = 6 V | 1 | 1.2 | – | |
| $\Delta V_{BEO}$ | difference between highest and lowest base-emitter voltage (offset voltage) | $I_{E1} = I_{E2}$ = 30 mA; $T_{amb}$ = 25 °C | 0 | 1 | – | mV |
| **AC characteristics of any single transistor** | | | | | | |
| $f_T$ | transition frequency | $I_C$ = 20 mA; $V_{CE}$ = 3 V; f = 1 GHz | – | 9 | – | GHz |
| $C_c$ | collector capacitance | $I_E = i_e$ = 0; $V_{CB}$ = 3 V; f = 1 MHz | – | 0.5 | – | pF |
| $C_{re}$ | feedback capacitance | $I_C$ = 0; $V_{CB}$ = 3 V; f = 1 MHz | – | 0.4 | – | pF |
| $G_{UM}$ | maximum unilateral power gain; note 1 | $I_C$ = 20 mA; $V_{CE}$ = 3 V; $T_{amb}$ = 25 °C; f = 900 MHz | – | 15 | – | dB |
| | | $I_C$ = 20 mA; $V_{CE}$ = 3 V; $T_{amb}$ = 25 °C; f = 2 GHz | – | 9 | – | dB |
| $\lvert s_{21}\rvert^2$ | insertion power gain | $I_C$ = 20 mA; $V_{CE}$ = 3 V; f = 900 MHz; $T_{amb}$ = 25 °C | 13 | 14.5 | – | dB |
| F | noise figure | $I_C$ = 5 mA; $V_{CE}$ = 3 V; f = 900 MHz; $\Gamma_S = \Gamma_{opt}$ | – | 1.2 | 1.6 | dB |
| | | $I_C$ = 20 mA; $V_{CE}$ = 3 V; f = 900 MHz; $\Gamma_S = \Gamma_{opt}$ | – | 1.7 | 2.1 | dB |
| | | $I_C$ = 5 mA; $V_{CE}$ = 3 V; f = 2 GHz; $\Gamma_S = \Gamma_{opt}$ | – | 1.9 | – | dB |

**Note**

1. $G_{UM}$ is the maximum unilateral power gain, assuming $s_{12}$ is zero. $G_{UM} = 10 \log \frac{\lvert s_{21}\rvert^2}{(1-\lvert s_{11}\rvert^2)(1-\lvert s_{22}\rvert^2)}$ dB

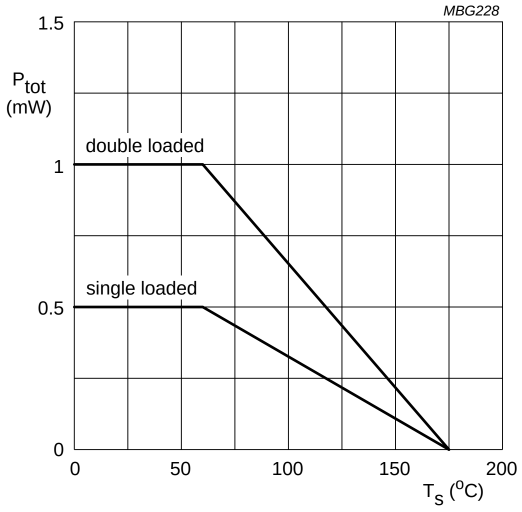
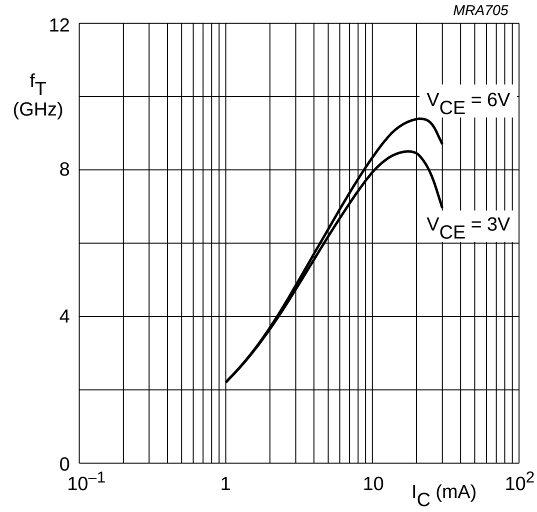
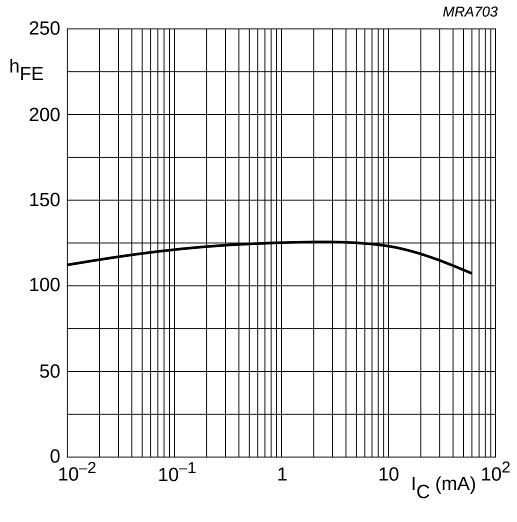



Fig.2 Power derating as a function of soldering point temperature; typical values.



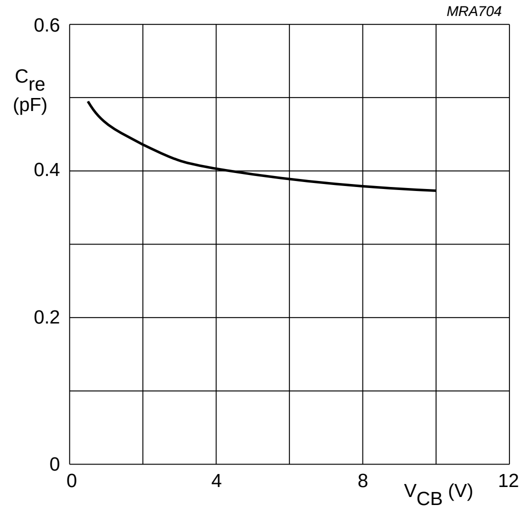

f = 1 GHz; $T_{amb}$ = 25 °C.

Fig.3 Transition frequency as a function of collector current; typical values.



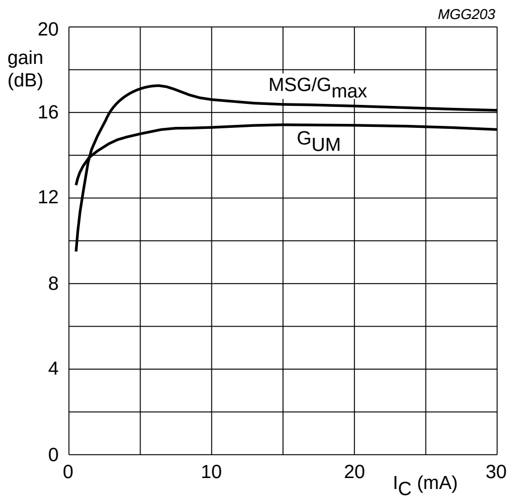

$V_{CE}$ = 6 V.

Fig.4 DC current gain as a function of collector current; typical values.



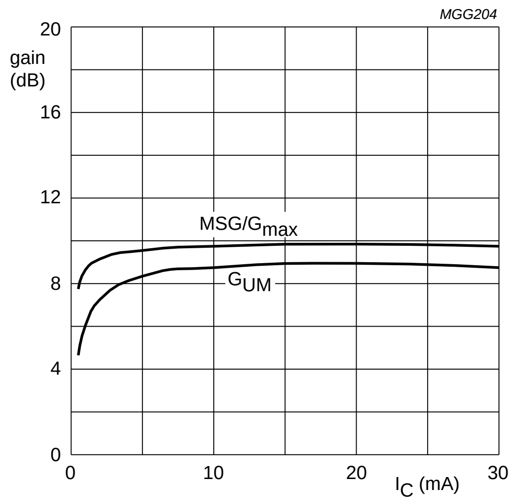

$I_C$ = 0; f = 1 MHz.

Fig.5 Feedback capacitance as a function of collector-base voltage; typical values.



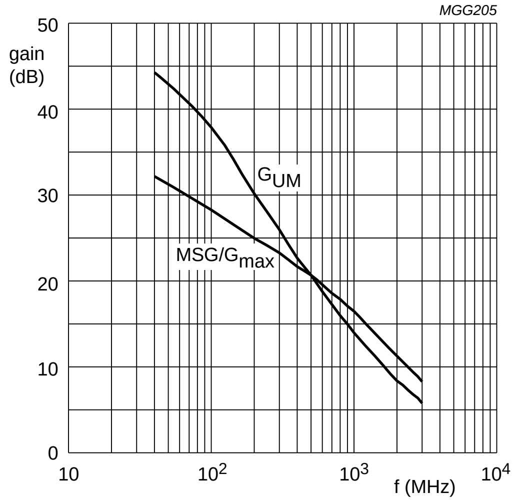

f = 900 MHz; $V_{CE}$ = 3 V.

Fig.6 Gain as a function of collector current; typical values.



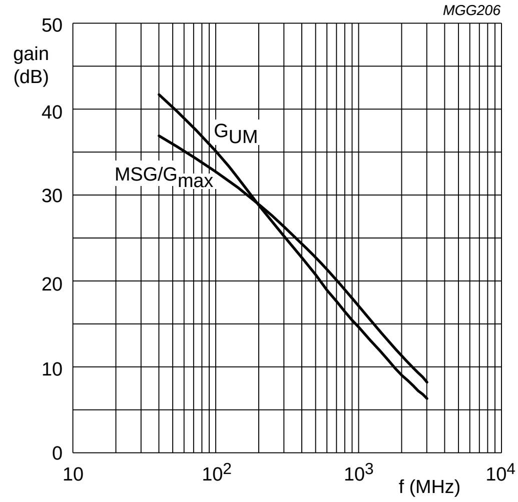

f = 2 GHz; $V_{CE}$ = 3 V.

Fig.7 Gain as a function of collector current; typical values.



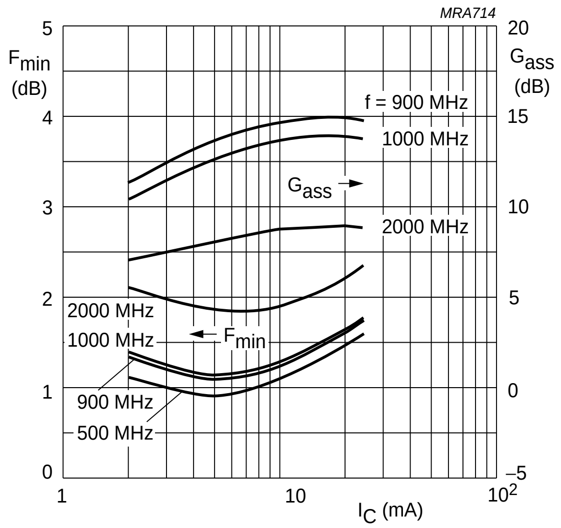

$I_C$ = 5 mA; $V_{CE}$ = 3 V.

Fig.8 Gain as a function of frequency; typical values.



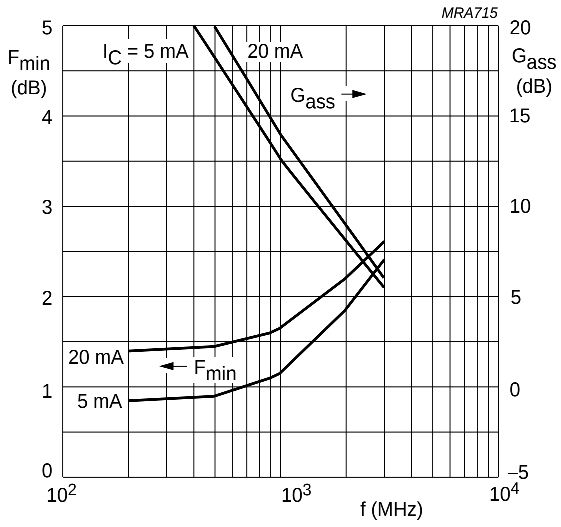

$I_C$ = 20 mA; $V_{CE}$ = 3 V.

Fig.9 Gain as a function of frequency; typical values.




$V_{CE}$ = 3 V.

Fig.10 Minimum noise figure and associated available gain as functions of collector current.




$V_{CE}$ = 3 V.

Fig.11 Minimum noise figure and associated available gain as functions of frequency.

## APPLICATION INFORMATION

### SPICE parameters for any single BFM520 die

| SEQUENCE No. | PARAMETER | VALUE | UNIT |
|---|---|---|---|
| 1 | IS | 1.016 | fA |
| 2 | BF | 220.1 | – |
| 3 | NF | 1.000 | – |
| 4 | VAF | 48.06 | V |
| 5 | IKF | 510.0 | mA |
| 6 | ISE | 283.0 | fA |
| 7 | NE | 2.035 | – |
| 8 | BR | 100.7 | – |
| 9 | NR | 0.988 | – |
| 10 | VAR | 1.692 | V |
| 11 | IKR | 2.352 | mA |
| 12 | ISC | 24.48 | aA |
| 13 | NC | 1.022 | – |
| 14 | RB | 10.00 | Ω |
| 15 | IRB | 1.000 | μA |
| 16 | RBM | 10.00 | Ω |
| 17 | RE | 0.775 | Ω |
| 18 | RC | 2.210 | Ω |
| 19(1) | XTB | 0.000 | – |
| 20(1) | EG | 1.110 | eV |
| 21(1) | XTI | 3.000 | – |
| 22 | CJE | 1.245 | pF |
| 23 | VJE | 600.0 | mV |
| 24 | MJE | 0.258 | – |
| 25 | TF | 8.616 | ps |
| 26 | XTF | 6.788 | – |
| 27 | VTF | 1.414 | V |
| 28 | ITF | 110.3 | mA |
| 29 | PTF | 45.01 | deg |
| 30 | CJC | 447.6 | fF |
| 31 | VJC | 189.2 | mV |
| 32 | MJC | 0.071 | – |
| 33 | XCJC | 0.130 | – |
| 34 | TR | 543.7 | ps |
| 35(1) | CJS | 0.000 | F |
| 36(1) | VJS | 750.0 | mV |
| 37(1) | MJS | 0.000 | – |
| 38 | FC | 0.780 | – |

**Note**

1. These parameters have not been extracted, the default values are shown.

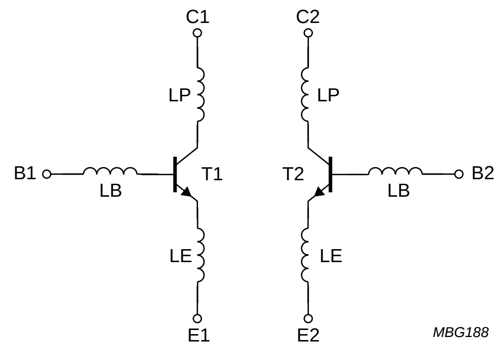



Fig.12 Package equivalent circuit SOT363A (inductance only).

Lead inductances (nH)

| | |
|---|---|
| LP | 0.4 |
| LB | 0.6 |
| LE | 1.0 |

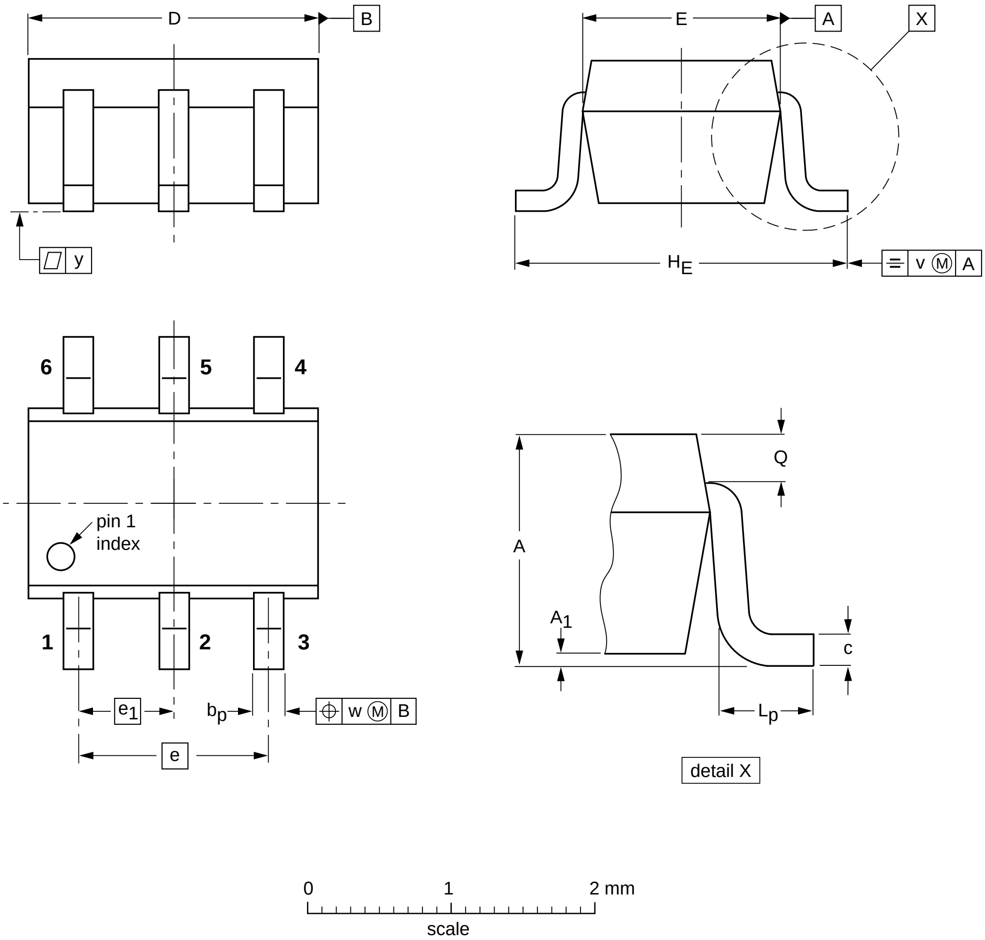
| | B1 | E2 | E1 | B2 | C2 |
|---|---|---|---|---|---|
| E2 | 3 | | | | |
| E1 | 27 | 6 | | | |
| B2 | 1 | 27 | 3 | | |
| C2 | 3 | 17 | 36 | 48 | |
| C1 | 48 | 36 | 17 | 3 | 6 |

MBG189

Fig.13 Package capacitance (fF) between indicated nodes.

## PACKAGE OUTLINE

**Plastic surface-mounted package; 6 leads** **SOT363**




**DIMENSIONS (mm are the original dimensions)**

| UNIT | A | $A_1$ max | $b_p$ | c | D | E | e | $e_1$ | $H_E$ | $L_p$ | Q | v | w | y |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 1.1<br>0.8 | 0.1 | 0.30<br>0.20 | 0.25<br>0.10 | 2.2<br>1.8 | 1.35<br>1.15 | 1.3 | 0.65 | 2.2<br>2.0 | 0.45<br>0.15 | 0.25<br>0.15 | 0.2 | 0.2 | 0.1 |

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | JEITA | | | |
| SOT363 | | | SC-88 | | | ~~04-11-08~~<br>06-03-16 |

## DATA SHEET STATUS

| DOCUMENT STATUS(1) | PRODUCT STATUS(2) | DEFINITION |
|---|---|---|
| Objective data sheet | Development | This document contains data from the objective specification for product development. |
| Preliminary data sheet | Qualification | This document contains data from the preliminary specification. |
| Product data sheet | Production | This document contains the product specification. |

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